Tutorial for triaxial simulations with the DEM

Note:

The script "script-session1.py" coming with the yade package is an improved version of the one initialy provided during ALERT O.Z. school in Grenoble. The main change concerns the procedure used to reach a sprecified porosity, based on the REFD algorithm initialy proposed in [1].
For this reason, the REFD method is not commented in the pdf version of the tutorial. See [2] for a more detailed description of this algorithm.

[1] Chareyre B., Briancon L., Villard P., Theoretical versus experimental modeling of the anchorage capacity of geotextiles in trenches, Geosynthetics International (9), pages 97–123, 2002. (fulltext) (fulltext)

[2] Tong A.-T. , Catalano E., Chareyre B., Pore-Scale Flow Simulations: Model Predictions Compared with Experiments on Bi-Dispersed Granular Assemblies, Oil & Gas Science and Technology – Rev. IFP Energies nouvelles, 2012, DOI: 10.2516/ogst/2012032 (fulltext)

Numerical Session 1 :

Introduction to Yade and Triaxial Simulations

Basics

1) Have a look at « hands-on » section of Yade's tutorial. It will give some basic informations on linux and python if needed.

2) Load the script triax-base-OZ.py in Yade, and run some iterations (at least 1000). Before examining the content of the script, we will use the simulation it creates to test different methods for moving around with Yade.
Check the « data-mining » section of the tutorial and test each commands in the current simulation. Inspect the graphical user interface.
Press the « inspect » button and visit engines, bodies and interactions.

Triaxial simulation

We will analyse the different part of the script triax-base-OZ.py. This script has many parameters. Make sure you understand the meaning of each of them, else ask the professors.

In this script, all parameters have default values so that the script gives correct results initialy. Modifying some values may break something, and it can be quite interesting to try and understand why. Indeed, the average user needs to define simulations correctly without prior knowledge of correct settings, and learning to find what's going wrong is part of learning DEM simulation.

1) Particles sizes and positions

1.1) There are different ways to generate particle sizes distributions using the makeCloud function. Execute the example script psd.py (yade-daily /usr/share/doc/yade-daily/scipts/test/psd.py), and check in psd.py how the different distributions are obtained. Choose one distribution for your simulations.

1.2) Plot the contact orientation distribution with the function plot *plotDirections()*. You will find maxima along x,y,z axis. Can you explain this result ?

1.3) Check the function's documentation to try and find a way to eliminate this artifact.

2) Confinment

Uncomment the next section of the script (select the code block and press ctrl+shift+D). With this section, the script will run iterations until the unbalanced force reaches a defined value.

During the simulation, different variables are written by the engine TriaxialStressRecorder to text file WallStress_myName. Examine the columns names in this file, and plot the evolution of the unbalanced force during iterations :

```
gnuplot
gnuplot> plot './WallStresses_triax_base_' using 1:3
gnuplot> plot './WallStresses_triax_base_' using 1:3 w lines
gnuplot> replot './WallStresses_triax_base_' using 1:2 w lines
```

3) Deviatoric loading

The next section of the script concerns deviatoric loading. Uncomment it and examine the code.

3.1) Add some code to run the simulation up to eps22=20%.

3.2) Run the script and analyse the results in order to define macro-mechanical parameters listed in the triaxialTestResults file of yade-school repository.

3.3) Add a line in this file with your results and an identifier name (so that we can latter retrieve the script that was used for each result). Create a directory in the yade-school folder with the corresponding script and any other usefull data.

3.4) Commit the results to the public repository (see launchpad/bazaar instructions).

4) Batch execution

Make a parametric study using yade-daily-batch (see https://yade-dem.org/doc/tutorial-geo.html#parametric-studies). Different sorts of comparisons can be meaningfull recommended :

4.1) Different micromechanical parameters leading to different packings (e.g. compFricDegree)

4.2) Different numerical parameters on the same packing (which should ideally give the same results in the quasistatic limit, e.g. Damping, loading rate...)

4.3) Different runs of the same simulation, when only the initial random positioning differs (usefull to evaluate dispersion as a function of the number of particles).